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RESEARCH PROGRAM

STUDY PLANS

Line Project No.: FS-PNW-2204 (Rev.)

U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE  
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION  
DIVISION OF FOREST INSECT RESEARCH

WORK PLAN

BIOLOGICAL CHARACTERISTICS OF THE EUROPEAN PINE SHOOT MOTH  
PERTINENT TO METHODS OF RELEASE AND TO EVALUATION OF POPULATION  
QUALITY IN APPLYING THE STERILE-MALE TECHNIQUE

By

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Portland, Oregon  
June 16, 1965

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STUDY PLAN APPROVAL

TITLE: Biological characteristics of the European pine shoot moth pertinent to methods of release and to evaluation of population quality in applying the sterile-male technique.

LINE PROJECT NO.: FS-PNW-2204 (Rev.)

Author's signature HK Carter

Date June 16, 1965

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Signature

REVIEWED AND

RECOMMENDED BY: \_\_\_\_\_

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APPROVED BY: June 16, 1965

V.M. Carolin Jr.  
Project Leader

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SUMMARY:

This plan proposes two types of studies pertinent to developing the sterile-male technique for controlling or eradicating the European pine shoot moth. Studies on methods of release are concerned with emergence patterns of the adult moths, pre-mating habits of the virgin females, and dispersion of released males. Studies on standards to indicate population quality deal with male longevity, male aggressiveness, and female fecundity.

## WORK PLAN

### BIOLOGICAL CHARACTERISTICS OF THE EUROPEAN PINE SHOOT MOTH PERTINENT TO METHODS OF RELEASE AND TO EVALUATION OF POPULATION QUALITY IN APPLYING THE STERILE-MALE TECHNIQUE

## INTRODUCTION

Starting in 1965, research on the European pine shoot moth will be expanded in an effort to develop a method for eradicating the pest from the Puget Sound area of western Washington. The method of eradication chosen as having the best chance for success is the sterile-male technique. This technique has been used successfully by Agricultural Research Service entomologists to eradicate the screw-worm in southeastern U. S. and is currently being tested against the codling moth. Briefly it involves rearing, sterilizing, and releasing large numbers of male insects into the natural population, thereby lowering the rate of reproduction, causing a downward population trend.

To accelerate research a coordinated program has been organized utilizing the research-team approach. Two phases of the program have been assigned as grant research projects to entomologists at Washington State University; one Forest Service entomologist will work on another phase; and the writer will work on a fourth phase. The entomologists and their assigned studies on European pine shoot are as follows:

#### Washington State University

Harwood - nutritional and developmental requirements.

Berryman - methods of inducing sexual sterility.

#### P.N.W. Forest and Range Experiment Station

Daterman - methods of regulating mating in the laboratory,  
and evaluating olfactory responses. 1/

Coulter - methods of release, and of evaluating the quality  
of the insects to be released.

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1/ Daterman, G. E. Mating behavior and olfactory responses of the European pine shoot moth. Work Plan. Division of Forest Insect Research, P.N.W. Forest and Range Experiment Station. May 10, 1965.

2.

The studies of Harwood, Berryman, and Datterman are mainly laboratory oriented to develop specific techniques for producing large numbers of sexually sterile male moths. The studies presented in this work plan are mainly field oriented to develop methods of releasing these males so that they effectively compete in mating with the normal males in field populations. Effective mating competition depends on the timing and the quantity of the release, and on the dispersal and mating aggressiveness of the sterile males released. This study will also investigate biological characteristics of field populations relative to establishing standards of population quality for reared and sterilized adults.

#### OBJECTIVES

It is estimated that three to five years will be required to develop the methodology for applying this eradication technique. At the present time the goal is to field-test the sterile male technique by 1967. The most urgent research needs relative to methods of release and biological standards are as follows:

##### A. Methods of release.

1. To determine daily and seasonal emergence patterns of the adult moths.
2. To determine the premating habits of the virgin female.
3. To develop a technique for obtaining quantitative data on the dispersion of released males.

##### B. Standards of population quality.

1. To determine the longevity of males in the field.
2. To determine if female mortality due to excessive mating or harassment is a measure of male aggressiveness.
3. To determine the fecundity of wild populations.

#### PROCEDURES

##### A. Methods of release.

Three aspects of the methods of releasing sterile males to obtain effective mating will be studied in 1965. These studies are related to the time and place of release. Pertinent findings from other studies are that the females mate only once, that it usually occurs on the day of emergence, and that unless disturbed, females fly readily only after they have mated. No study has previously been made of male dispersion.

1. Emergence pattern of the adult moths. Both daily and seasonal emergence patterns will be studied using the methods described by Pointing. 2/

Records of the daily pattern will be made early in the emergence period and repeated once near the peak of the emergence period. A minimum of 300 infested shoots will be inspected every 15 minutes during the peak hours to observe emergence and behavior of the adults according to sex.

The seasonal emergence pattern will be determined by removing and sexing empty pupal cases from entire trees. To facilitate this procedure all infested shoots on the study trees will be conspicuously marked. A minimum of 500 shoots on light or moderately infested trees, preferably mugho pine, will be inspected every other day until all adults have emerged.

2. Premating habits of the female. 3/ The habits of female moths following emergence determines where the treated males must be released. In 1965 a study will be made to determine if the female moths in the Puget Sound infestation normally fly before mating. Observations will also be made to identify the types of disturbances that cause the virgin female to fly prematurely, thereby altering their pattern of distribution.

Records of the behavior of the virgin female will be made during studies of the adult's daily emergence pattern. Each emerging female will be inspected at 15 minute intervals from the time of emergence through the evening flight and mating period until mating occurs. (The mated pairs will be collected and isolated for other studies). Females disturbed into flight before mating occurs will be noted and the cause of the disturbance recorded.

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2/ Pointing, P. J. The biology and behavior of the European pine shoot moth, *Rhyacionia buoliana* (Schiff.), in southern Ontario. I Adult. Can. Ent. 93(12): 1098-1112, illus. 1961.

3/ Other workers, particularly Daterman, will also be studying this problem. See Daterman's work plan previously cited.

4.

3. Dispersion of released males. A technique of marking, releasing, and subsequently detecting adult males will be tested jointly with Daterman. A large number of young virgin males will be marked with calcofluor, a proprietary fluorescent dye, or another dye shown promising in Daterman's tests. They will be released in the vicinity of lightly infested pines (to lessen the factor of female attraction) offering a range of 300 feet in at least two cardinal directions. A plat will be drawn to scale showing the release point, the host pines and other major plants; recording plant species, their approximate size, distances from release point, and major features of topography. Release will be made on a day of average weather and about one hour before normal flight begins. A day of average weather is defined as a day when normal, spontaneous flight would occur readily. The weather at release time must be warm (about 60°F to 70°F), clear or slightly overcast, and preferably with a light wind of 3 to 10 m.p.h.

Surveys will be made every 15 minutes on the first day of release until one hour after flight ceases, using a portable ultra-violet lamp. A survey will be made early the second day to detect a shift in the dispersion pattern and the need for additional surveys between flight periods. Surveys during subsequent evening flight periods will be scheduled to detect major changes in the dispersion pattern.

A small number of marked moths will be caged in the field as a check on the rate of deterioration or loss of the marking material.

#### B. Standards of population quality.

Three biological characteristics related to the vigor of adult shoot moths will be studied in 1965. These are male longevity, male aggressiveness, and female fecundity. Since the control technique depends on flooding the normal population with sterile males which compete in mating with the normal males, the sterile males released must be as aggressive as the normal males. Furthermore, since large numbers of insects must be reared, the fecundity of the reared insects will have an important bearing on the efficiency of the entire procedure, as well as providing an index of population quality.

Little information is available on the three biological characteristics to be studied. Pointing was able to show in laboratory tests that males are capable of mating at least four times. Therefore, while aging probably lessens mating ability, the longevity of the released males must equal that of the normal males to maintain the desired numerical superiority and mating competition.

B. A. Butt reports that in studies on control of the codling moth, "preliminary tests for male sexual aggressiveness, using the criterion of female mortality look quite promising." <sup>4/</sup> The codling moth is a close relative of the shoot moth.

In southern Ontario the fecundity of the wild population caged on trees in the field was found to average 63 eggs per female according to Pointing. This was about one-half the average number of eggs he obtained when normal, mated females were caged in the laboratory. He attributes this apparent reduction in fecundity to "a shorter adult life occasioned by predators in the cages, or increases in other activities; e.g., flying, which would reduce the energy available for egg laying." Pointing's study of normal fecundity in wild populations in the field is the only one that has been attempted, probably because of problems in caging to simulate natural conditions, assessment of the effects of predators, and recovery of the eggs laid.

1. Longevity of males. Newly emerged, normal males will be caged on trees in the field to determine longevity. These will be examined periodically until mortality begins and then daily records will be kept to record the rate of mortality and average longevity.

The supply of males will be obtained by mass rearing infested shoots in the laboratory. The emerging males will be caged on small potted pines from which all predators have been removed.

2. Female mortality as a measure of male aggressiveness. Tests will be made to determine the effects of excessive mating or harassment on female longevity. Different ratios of males to females will be caged and female mortality recorded. The following ratios will be tested: 0:1, 1:1, 3:1, and 5:1. Each ratio will be replicated at least five times. Virgin females will be obtained by rearing isolated infested shoots in the laboratory. Newly emerged males for the test (not more than 48 hours old) will be obtained by mass rearing infested shoots. The dead females will be examined to determine the cause of death, particularly evidence of harassment. The cages will be examined for deposition of fertile eggs, indicating at least one copulation.

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<sup>4/</sup> Butt, B. A. Personal correspondence. Arid Areas Deciduous Fruit Insect Investigations. Agr. Res. Serv., Yakima, Wash., Feb. 1965.

6.

3. Fecundity of wild populations. A standard of female fecundity will be established for controlled laboratory conditions. Normal, virgin males and females will be reared from field-collected pupae in shoots and mated in the laboratory using methods developed by Daterman in his current studies. Virgin moths will be obtained by isolating infested shoots in small plastic cages in the laboratory. Male-female pairs will be re-caged for mating. After mating is completed the females will be isolated in one-quart oviposition cages described in the progress report for 1964. <sup>5/</sup> A honey and water solution will be provided for food. All cages will be kept at average laboratory conditions of heat and light. The isolated females will not be disturbed, except to replenish the food solution, until each dies.

#### WEATHER RECORDS

Local, daily Weather Bureau records for the Seattle area will be used as standard references in these studies. Weather deviations at study sites will be recorded whenever possible. Continuous detailed recordings at the study sites will not be possible because of the possibility of damage or loss of instruments in the urban districts where the studies will be made.

#### COOPERATION

These studies are part of a coordinated research program with Washington State University at Pullman, Wash., in which the Washington Department of Natural Resources provides assistance in field collections and transportation of material under quarantine conditions.

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<sup>5/</sup> Coulter, W. K. Biology and behavior of the European pine shoot moth in western Washington, 1964. Progress report. Processed. Pac. NW. Forest and Range Expt. Sta. 18 pp., illus., May 1965.



## ESTIMATED COSTS

<u>Salary</u>	FY <u>1965</u>	FY <u>1966</u>	<u>Total</u>
Permanent employee, GS-11 (24 weeks)	\$ 733	\$3,664	\$ 4,397
Temporary employee, GS-5 (14 weeks)	288	1,056	1,344
Temporary employee, GS-4 ( 4 weeks)	172	172	344
 <u>Per diem</u>			
Permanent employee, GS-11	182	936	1,118
Temporary employee, GS-5	140	660	800
Temporary employee, GS-4	140	154	294
 <u>Transportation</u>			
Permanent employee, GS-11	110	660	770
Temporary employee, GS-5	110	550	660
Temporary employee, GS-4	110	110	220
 <u>Miscellaneous</u>			
Special equipment and supplies	<u>125</u>	<u>250</u>	<u>375</u>
Total	\$2,110	\$8,212	\$10,322

## PUBLICATION PLANS

These studies in 1965 will be reported in a Division Progress Report pending further investigations and conclusive results leading to a field test of the eradication technique.